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The promise of microwaves for solar energy harvesting

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Non-fossil energy sources have become a serious contender to fossil fuels for many obvious reasons. The migration to non-fossil based sources such as wind, water, nuclear and solar has been accelerating despite non-market based forces leading to occasional dips in oil and gas prices. Therefore, research in non-fossil energy sources will continue to accelerate at rates significantly faster than any previous times. The most abundant energy source is the Sun. Harvesting solar energy is possible through classical solar cells. The fundamental limitations of the photovoltaic technology should not be considered as a limitation on our ability to harvest the sun's energy. Wireless power transfer (WPT) using microwaves is a highly viable technology that can harvest solar power at potentially much higher efficiency levels than achieved by direct use of photovoltaic cells. WPT starts by harvesting solar power in outer space using satellites and then converting the power to microwaves for transmission to earth. On earth, recetenna farms will then collect the powers beamed from satellites. A major component of the WPT system is the microwaves energy collector, i.e., the antenna. Classical antennas have limitations that limit their efficiency. Metamaterials can exceed the efficiency of classical antennas and can enable a much higher harvesting efficiency. Metamaterials are made of an ensemble of electrically-small resonators. Resonance of each particle of a metamaterial is fundamentally indicative of its ability to store energy. Metamaterials, therefore, can be effective energy harvesters. This does not come as a surprise since metamaterials have been shown to be effective absorbers. However, in the case of absorption, the absorbed energy is mostly dissipated in the dielectric host. For the effective use of metamaterial as energy harvesters, not only the energy absorption is of high importance but also channeling the absorbed energy into energy collection channels is critical. In this talk, I will demonstrate that metamaterials can indeed be effective electromagnetic energy harvesters and can provide energy harvesting efficiency appreciably higher than what classical antennas can achieve.

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Numerical simulation of the thermal behavior of heat storage for an application in the drying of cocoa beans

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The results of numerical simulation of thermal behavior of heat storage, sized for drying 13 kg of cocoa beans in phase of stocking and destocking are presented here. For the stocking phase which takes place from 6:00 AM to 4:00 PM, the evolution of the temperature of the stones, versus the time is studied. For the destocking phase which takes place from 4:00 PM to 6:00 AM, the evolution of the temperatures of the stones and that of the working fluid (air) passing through the stones bed (stocking materials) are studied. A particular attention is focused on the evolution of the temperature at which the working fluid exits from the storer. These simulations were carried out in the meteorological conditions of the city of Yamoussoukro in Ivory Coast. The results show that the maximum temperature reached by the stones is 63º C at 15:20 PM for the stocking phase. These results also show that the temperature of the working fluid leaving the storer is 40º C around 6:00 AM. The simulation results show that the quantity of energy stored is sufficient for drying the beans during non-sunlight.

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